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THE AGRICULTURAL ASPECT OF THE COCO-NUT INDUSTRY IN THE MANDATED TERRITORY OF NEW GUINEA

BY

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Introduction.

The staple agricultural industry in the Mandated Territory of New Guinea is the cultivation of coco-nuts, and the manufacture of coco-nut products such as copra, desiccated coco-nut, and coir fibre; the equity in the numerous plantations being considerable.

It will be shown in the course of this paper, that the outlook at present, relative to the future maintenance of production, will apparently depend to a large extent on the development of new areas.

That the period when the output must decrease as a whole, should be governed by the availability and suitability of virgin areas gives cause for alarm. Obviously, there must be a limit to the suitable areas and the resources of the planter for new development. It might be argued that thousands of hectares still remain undeveloped, but when consideration is given to the area planted in the past thirty to forty years, even in the last ten years, it will be realized that the area of suitable land is not so great after all.

Economic conditions throughout the world in recent years have been most unfavorable towards the primary producer. The price of copra has been depressed, and the planter in this Territory has suffered severe financial loss. Therefore, even should he desire to develop new areas he is handicapped through lack of finance.

That New Guinea possesses large mineral resources is beyond doubt, and the present revenue derived from the gold output is considerable. However, mining is invariably only a passing phase in the development of a new country, the real backbone of prosperity being agriculture. Therefore, the immediate problem facing not only the planting interests, but the Territory as a whole, is the maintenance of the chief agricultural industry—coco-nuts.

The object of this paper is threefold—

(1) To outline the products and uses of the coco-nut palm.

(2) To endeavour to present, quite impartially and non-critically, the existing coco-nut position.

(3) To point out the methods possible of adoption for the improvement of bearing estates, reduction in costs, and development of new areas.

It should be realized that in this Territory very little scientific agricultural data are available, and that many of the ideas postulated are open to criticism, and subject to modification when further information does become available. The co-operation of everybody interested in the agricultural welfare of the Territory is sought, and it is hoped that planters and others will assist the industry by tendering their experiences, ideas, theories, &c.

Section No. 1.

THE PRODUCTS AND USES OF THE COCO-NUT PALM.

The palm stems may be used as hollowed trunks for water pipes or as wood for fuel, and in cut lengths for doors, window posts, house supports, &c. In India and Ceylon the outside wood known as "Porcupine Wood" has been successfully polished for interior decorations.

The leaves can be used for the manufacture of roofing materials and walls, such as "bom boms" for native houses, plant nurseries, &c., or made into native baskets, temporary seed baskets for cacao and coffee plants and used as wrapper with many of the purposes of paper. The central ribs of the fronds yield bristles for brooms, while the dried leaves furnish fuel.

In some countries the flower stalks are tapped and the saccharine juice obtained can be used for the production of sugar, or when fermented becomes "Toddy" or "Arrack".

The roots are often used medicinally by natives as an astringent, and according to Watt[13] the fresh fruit has an anthelminthic action, while the "milk" from unripe fruits is recommended as a useful refrigerant in fever and urinary disorders.*

The nuts have a wide variety of uses (dependent on the portion involved) and practically every plant has a commercial value, as even the coco-nut milk can be used as food for pigs.

The husk is used for the extraction of coir fibre by various commercial processes, while in some countries it is purely a cottage industry, with the retting carried out by primitive processes.

Dr. Barker stated[1] "that the fact that coir properly treated resists decay, is not disintegrated by bacteria or harmed by water and can easily be impregnated with bituminous and resinous materials, provides a unique opportunity for exploiting its use in directions untried in commerce and industry". An excellent report by the Empire Marketing Board[5] is available, on the attributes and preparation of coco-nut fibre.

The residues from the fibre extraction may be used as manure, and although the analysis compares somewhat unfavorably with cattle manure, the creation of such manures from waste products on the spot is worthy of consideration.

From the short fibre combined with ionized oil and rubber latex, a very good imitation leather with distinctly promising characteristics, has been obtained. It has also been successfully used in plastic mixtures with pitch or bitumen for pipe and cable coverings. The coir itself is manufactured into yarns, matting, rope, &c., and may be dyed and bleached.

The finest quality mat fibre is used for the manufacture of ropes, twines, and matting. The coarser and thicker quality fibre is employed in the manufacture of brushes and brooms, while the curled fibre of short strands is used for mattresses or for stuffing upholstery, &c.

Coir is very resistant to the action of water, is light in weight and exhibits good elasticity; it is therefore particularly suitable for certain types of ships' ropes, but is inferior in strength to Manila hemp and Sisal hemp.

* Taken to excess it causes a form of gleet.—*Editor.*

The coir has further uses in native villages as fishing net cords, and owing to its property of swelling when saturated with water, combined with its durability, it is found very useful in boat building and caulking.

The use of the half husk as a scrubber is well known here.

Experimentally it has been found possible to make softened coir which can be used for the production of fabric for sugar bags, and if this could be extended commercially to the production of copra bags, a very important cost in copra production would be reduced by utilizing the waste product.

Bags made of coir yarn, owing to their resistance to decay, are stated to be specially suitable for the carriage of superphosphates and other inorganic fertilizers. Coir bags are understood to be used locally in Ceylon for transporting copra to the oil mills, and carrying coal for loading into ships' bunkers. Coal bags made of coir are also employed to some extent in Europe. When the price of jute is high it is conceivable that coir yarn could be used instead for bag making, but jute is naturally preferred for this purpose and sacks made from coir are much heavier than those made from jute.

The ash derived from the husk is rich in potash and manurial constituents, (*see* section No. 3.).

A local company has commenced in this Territory to manufacture coir fibre and its products on a small scale, but so far only experimental shipments have been made. There is still much room for a study of the natural qualities of the husks and fibres, particularly to find out how the local product compares with that from overseas.

Unless much wider uses are found for the product, so as to make processing more profitable, under the particular conditions obtaining here it is not expected that the industry will expand to any great extent in New Guinea, as coir is easily overproduced. The method of harvesting the nuts, and the labour available, would not assist the industry, unless it was carried out in conjunction with the production of desiccated coco-nut, where the nuts are harvested at an earlier stage of maturity.

As far as is known no coir fibre is spun in Australia, and the coco-nut fibre which eventually is converted into ropes or mats is imported as yarn, chiefly from India.

The average 1935 price of coir fibre is quoted at approximately £7 12s. 8d. Australian per ton, coir yarn is quoted at about £14 4s. 7d. per ton sterling, which at current rates of exchange is equivalent to £18 18s. 6d. In the case of New Guinea fibre the bounty of £3 per ton must be taken into account.

The utilization of the shell, especially by destructive distillation, has not been developed to its maximum extent, and chemical research may prove this a valuable by-product of the industry. Nevertheless the present uses of the shell are extremely diverse.

The products of destructive distillation of the coco-nut shell have been calculated experimentally by Georgi and Buckley,[7] and the amounts of the various products, based on 100 lb. of shells are shown as follow:—

Charcoal	49.0 lb.
Pyroligneous acid	2.88 gals.
Tar	0.26 gals.
Acetic acid (calc.)	4.68 lb.
Methyl alcohol	0.07 gals.
Crude creosote oil	0.13 gals.

The value of pure vegetable charcoal is well known for its uses in medicinal filters, explosive manufacture, &c.

According to Georgi and Buckley[7] there is only a limited demand for charcoal from copra apart from its use as fuel in suction gas engines, where special scrubbers have to be provided to use it efficiently. It has two other main uses, viz. decolourizing agent for fluids and absorbents for noxious gases, and during the great war coco-nut shell charcoal was used on an enormous scale in the filling of gas respirators.

The coco-nut shells may form a valuable source of supply for acetic acid, creosote for wood preservation, and wood spirit (naphtha) for use either as a denaturant for alcohol or in the preparation of pure methyl alcohol.

According to Barker[1] a still was designed capable of yielding five gallons of pyroligneous acid per day. There is a small sale for this acid in the meat trade, where it is used as a substitute for the smoking process.

The wood tar from coco-nuts finds a limited industrial use, either as an insulating compound, or as a rope lubricant, but needs a good deal of refining. The percentages of acetic acid and acetone obtained from the brown aqueous distillate, known as pryoligneous acid, are considerable and a wide commercial use for these products is assured, though plenty of other sources are available.

A sample of tarry distillate produced and submitted for analysis by a local planter gave results comparable with the above.

The shell itself provides sources for fuel for copra driers, &c., and could be used as a source of power in gas engines. The hard shell has a variety of uses for the natives, and may be used as food and drinking vessels, lamps, spoons, and in some countries as cups for rubber latex collection.

Copra.

Copra is prepared from the dried kernel of the coco-nut, usually when it is fully matured and after it has been cut open and the husk, and usually the shell, removed.

Copra drying is carried out by various methods, either by taking advantage of natural sun or using smoke, machine and hot air driers. This subject is discussed elsewhere in a previous article[9] and will be the subject of future publications.

Copra is employed exclusively in the manufacture of coco-nut oil, the quality of which depends on the quality of the copra crushed. Good copra produces an oil with a minimum amount of free fatty acid, suitable when refined for edible

purposes, whereas oil expressed from lower grade copra is mostly used for soap making. Under modern conditions rather inferior copra can be deodorized and neutralized for edible purposes.

Coco-nut Oil—Preparation.

The natives of tropical countries prepare coco-nut oil by primitive methods, such as cutting the kernel in small pieces and exposing these in heaps to the sun, when the oil melts and runs off. Another method is to crush the kernels to pulp in wooden mortars and place the pulp in perforated vessels in the sun, the oil which exudes being collected. A simple and more efficient method consists in first drying the kernels either in the sun or over a fire, pounding the dried material, and pressing in wooden presses. Oil of good quality may also be obtained by throwing the pounded kernels into boiling water and skimming off the oil as it rises to the surface.

Modern methods of copra crushing and extraction of coco-nut oil are outside the scope of this article, but modern milling machinery is becoming more efficient and less complicated every year. Thus the new type expellers, such as as are manufactured by Rosedowns, England, require less power than formerly and are said to be capable of being adjusted to deal with several types of oil bearing seeds and kernels.

The usual method of oil extraction is briefly described as follows:—

The copra is properly milled, the resultant meal being steamed and fashioned into large square cakes. The oil is expressed or squeezed from these cakes by submitting them to a hydraulic pressure of several tons to the square inch.

Properties of Coco-nut Oil.

Coco-nut oil in Europe is a solid, white fat, but it is a liquid oil at the high temperature prevailing in tropical countries. It has a pleasant taste and the peculiar and not unpleasant odour of the coco-nut. It has a specific gravity ranging from .873 to .926 according to the temperature and a melting point of 24 degrees centigrade. It closely resembles palm kernel oil in appearance and composition. It is a complete mixture of the glycerides of fatty acids, consisting principally of trilaurin and trimyrstin together with smaller quantities of tripalmutin, tristearin and triolein, and also glycerides of the volatile caproic, caprylic, and capric acids.

When carefully prepared, coco-nut oil does not turn rancid rapidly, but oil prepared in the tropics by primitive methods, and also oil prepared in the large importing countries from copra of poor quality, contains not only free fatty acid, but also other products, probably formed by the action of fungi or of enzymes on the kernels, which give the oil an unpleasant taste.

Uses of Coco-nut Oil.

Snodgrass[10] comments as follows:—

"The chemical composition of the oil is such that when refined it has excellent keeping qualities. It is also of bland flavour and has a consistency very similar to animal fats. So far it has not been widely used as a cooking fat because if combined with other oils and fats it foams when heated.

Only coco-nut oil of high grade, or oil from the highest grade copra which contains a minimum of fatty acids, is employed in the preparation of vegetable butters (margarine), &c. To render it suitable for this purpose, the free fatty acids and substances of unpleasant

odours are eliminated. A portion of the liquid glycerides is frequently removed by expression, the object being to prepare a fat of firmer consistency and higher melting point. The "coco-nut olein" which is removed, is employed in soap manufacture while glycerine is liberated as a by-product.

Coco-nut stearins of varying melting points can be prepared by removing from 50-80 per cent. of the 'olein', and when prepared from high grade oil the 'stearin' is employed as a chocolate fat, and as a substitute for the more expensive cocoa butter derived from cacao beans which has great use in confectionery manufacture."

Coco-nut "stearin" derived from lower grade copra oils is used for candle manufacture, the olein being made into soap. Again, according to Snodgrass[11] "the adaptability of coco-nut oil in making vegetable margarine, arises from various of its characteristics of which its melting point is probably the most important, and no other oil has proved as satisfactory in making this product on a commercial scale."

The aim is to obtain a material of about the same hardness as butter, with a consistency of "feeling to the tongue" that is similar, and a keeping quality as great. Coco-nut oil has a slightly lower melting point than butter, but remains sweet over long periods.

The relative absence of Vitamins A and D from ordinary margarine, is perhaps the most serious criticism which can be levelled against its use to replace butter. Not only has this difficulty been overcome, but an advance of some importance has been made in the development of a butter like aroma in margarine. It is based on the discovery that the characteristic aroma of freshly made butter is due in the main to an extremely small portion of diacetal.

Coco-nut oil being a non-drying oil is unsuitable for paint, and similar lines of manufacture, nor is it so adaptable as mineral oils for use as lubricants, nor as useful as certain vegetable and animal fats in the treatment of leather. The ease with which its soaps lather, and certain other qualities which the oil possesses, make it specially adaptable for soap making. It is light in colour, and for that reason desirable both for toilet and household uses. It has the almost unique property of lathering in salt water, besides holding an unusually large amount of water, and is therefore the principal fat used in marine soaps.

Coco-nut oil produces a higher rate of by-product glycerine in the process of soap making than most other oils and fats.

Appreciable quantities of coco-nut oil are used in cosmetics of various sorts, shampoos, perfumes and facial creams; fillings for sweets and cakes, and to some extent for salad dressings and lard compounds. A small amount is used for lubricating machinery, and new uses are being continually discovered.

The by-product glycerine has a great variety of uses in chemical and pharmaceutical preparations. It is stated to have use as anti-freeze in the automobile industry and is a valuable component of explosives, where trinitro-glycerine, dynamite and gelignite are evolved.

Soap and candle industries of Australia use approximately 900,000 to 1,000,000 lb. of coco-nut oil annually, from which over 1,000,000 lb. of soap are made. In 1928-29, 70,000 lb. of candles were manufactured but this dropped to 50,000 lb. in 1930-31. The value of total production of soap and candle factories in Australia ranges from approximately £1,500,000 per year.

In the United States vegetable oil margarine is manufactured almost exclusively, but in Europe and in other countries margarine made from hardened and refined animal fats is in direct competition with it.

Coco-nut Cake and Meal [4].

These are residual products of the crushing and extraction respectively of coco-nut oil from copra. The residue is a valuable concentrated cattle food containing a large percentage of oil, and is exported in considerable quantities from those copra-producing areas which also produce coco-nut oil on a large scale, such as the Philippine Islands, Dutch East Indies and Ceylon. The copra crushing countries, outside the copra producing areas, utilize almost the whole of this residual product for their livestock.

Utilization of Coco-nut Cake (Poonac).

The residual cake left after expression of the greater part of the oil, contains about 7 to 10 per cent. fat and forms a fairly nutritious cattle food for which purpose it is employed, both in the temperate zones and in the tropics.

The following table of analysis compares coco-nut cake with some of the oil seed cakes, commonly employed as feeding cakes:—

TABLE No. 1.[12]

Average Composition percentage by analysis.	Coco-nut cake.	Cotton seed cake.	Groundnut cake.	Linseed cake.
	%	%	%	%
Dry matter	89	88	90	89
Protein	20	23	50	31
Oil	10	5	8	10
Carbohyd. Sol...	41	32	22	32
Carbohyd. Fibre	12	21	5	9
Ash	6	5	5	6

Feeding tests in England have shown that the butter from cows fed on coco-nut cake is of good quality, and possesses better keeping qualities than that from the milk of cows fed on linseed cake or cotton seed cake.

The price of coco-nut cake (ex mill) during November, 1935, ranged from £6 to £7 per ton, and over a series of years usually varies from £6 to £10.

In Australia coco-nut cake has a wide use, particularly in periods of drought; it is popular on the Continent of Europe and in America.

Henry and Morrison[8] state in their book on *Feeds and Feeding* that the residue derived from the manufacture of oil from coco-nut is lower in crude protein than most other oil meals, but higher than in wheat bran. When fed to dairy cattle using about 3-4 lb. per head daily, the butter produced is of good quality and firmness. It may also be fed with success to horses, sheep, and pigs.

Coco-nut meal, especially that high in fat content, has a tendency to turn rancid in hot weather.

The following table (No. 2) gives particulars of the digestible nutrients per cent. of coco-nut cake:—

TABLE No. 2.[12]

Crude Protein.	Pure Protein.	Oil.	Carbohyd. Soluble.	Carbohyd. Fibre.	Nutritive ratio Approx. 1 to
15	15	9	34	8	4

The nutritive ratio can be defined as the ratio between the nitrogenous substances (crude protein) and the non-nitrogenous substances in the food [carbohydrates, i.e., sugars and starches + (fat × 2.25)]. This varies considerably in different classes of foods and here represents a relatively nitrogenous food with a "narrow" nutritive ratio.

The fertilizing constituents in 1,000 lb. of oil cake are roughly as follows:—

Nitrogen	33 lb.
Phosphoric acid	12.4 lb.
Potash	23.6 lb.

It is seen that the manurial value of residual oil cake is considerable, but it usually has more value as a feeding stuff.

Production of Shredded and Desiccated Coco-nut.

The use of these products in the production of confectionery, cakes and foods is too well known to require elaboration.

According to Eaton [3] the three principle products on the American market are—

(1) Fresh grated coco-nut canned in its own milk or water.

(2) Moist sweetened coco-nut with the milk, in cans.

(3) Dried shredded coco-nut prepared with sugar, in cardboard packages.

It is essential to use only fresh ripe nuts for the purpose, and it is estimated that about 5,000 to 7,000 nuts are required to produce 1 ton of desiccated coco-nut.

The nuts are first husked, then sterilized by steaming for an hour or two in a kiln under low pressure steam, which has the effect of loosening the kernel and admits of loosening the shell easily.[3] The brown skin is then pared off, the milk drained and the white meat shredded and dried immediately. Drying is done in several ways, and the shredded nut is stirred until quite dry.

The preparation of desiccated and shredded coco-nut entails the following operations:—

Husking, removal of the shell, removal of the skin or testa (usually done by hand), cutting and shredding by machine, drying and desiccation in suitable artificial driers. The dried product is then sifted in a "machine sifter," which together with grating machines can be regulated to produce a more granular product. This is then packed in lead lined cases for shipment.

The by-products are the rejected nuts, and the parings and tailings from the factory, all of which may be processed on the spot or exported as a source of oil.

The Fresh Coco-nut.

The use of the fresh coco-nut as an article of food by the natives, and the contained milk or water of the young nut (Kulau), by Europeans and natives as a refreshing beverage is a common feature of the life in New Guinea and other tropical countries.

Section No. 2.

THE EXISTING COCO-NUT POSITION.

Mainland of New Guinea.

The mainland of New Guinea, which is divided into three main districts, (Madang, Aitape/Sepik, Morobe), has an area of 70,000 square miles. There are few good harbours, the best being probably those of Madang, Vanimo, Alexishafen, Matzfeldt, Monumba, Finschhafen, Salamaua, and Morobe. Agricultural development of this huge tract of country is confined solely to the coastal belt.

Madang District.

The Madang district is a large district which has 56 plantations, containing about 12,600 hectares under coco-nuts, of which 10,000 hectares are in bearing. In many instances the growth of the palms is not satisfactory, especially in those areas where the soil, though rich, is shallow overlying limestone. In other places hilly areas are going back in production.

Several of the earliest planted properties show very little new planting since German days, some are over 40 years old and decreasing in yield, whilst others are just holding their own.

Between 60 and 70 per cent. of the estates have increased their yields since 1924, but in the majority of instances this may be attributed to new areas coming into bearing, or sections reaching full bearing.

On Kar-kar Island (Dampier Is.), the production shows rapid increase, many areas yielding over 1½ tons of copra per hectare.

There are approximately 700 hectares of recent plantings, while a number of palms are just coming into bearing. The land is fertile and has abundant underground water coming from the mountains in the centre of the island; the climate is equable, and the rainfall well distributed.

It is anticipated that many of the expropriated properties on the Madang coast will probably give reduced yields in the future; in fact a proportion of the plantation areas already appear to be going back, or have little future ahead of them. The newly planted areas will, however, balance the production on the poorer sections.

Up to the present most of the suitable areas with the best anchorages have been selected. There still remains probably 50,000 hectares more or less fit for planting, which is in the virgin state. Some of the areas along the coast have good anchorages, but there are some instances where large expanses of swamp are interspersed with the good land.

Sepik/Aitape District.

There has been little agricultural development in this district, only about 2,600 hectares being under cultivation on the eighteen plantations. Included in these are several old properties controlled by the Expropriation Board, and island properties such as Seleo and Wallis islands.

Generally speaking this district will maintain its production, although very few new areas have been planted.

The Aitape coast is practically an open roadstead, anchorages are few, and loading is so difficult that it is often impossible for vessels to load or discharge cargo.

It is anticipated that little new planting of coco-nuts will occur here, owing mainly to the lack of anchorages and because more suitable areas are available in other districts.

Morobe District.

The Morobe district has yet to be developed agriculturally, the twelve plantations owned by Europeans comprising only about 1,400 hectares of coco-nuts.

There are few good anchorages along the mainland coast, Finschhafen, Salamaua, and Morobe being perhaps the best.

The Mission properties should maintain their present production as soil is good and they are well worked, although one property situated in the Huon Gulf is decreasing. The Government and other plantations will probably decrease in yield.

In the Siassi Island group, Sexava has been troublesome but the planted areas are young and the yield will increase slightly.

Generally speaking, the district as a whole can be expected to decrease unless new areas are planted, or the existing estates are improved.

New Britain.

The island of New Britain is the largest and most important island of the Bismarck Archipelago. It is 300 miles long, and average breadth of 50 miles, and has an area of 13,000 square miles [14].

A high rugged mountain range runs throughout the length of the island, and volcanic action is still very evident. Mount Ulamon ("the Father") (7,500 ft.) is the highest peak and an active volcano.

New Britain possesses several good harbours, Simpsons Harbour, Passage-Man-O-War, Powell Harbour, Rein Bay, and Talasea Harbour, being perhaps the best. There are also numerous anchorages suitable for schooners and small inter-island steamers.

For the purpose of this paper New Britain has been divided into the following districts:—Rabaul/Kokopo, Duke of York, Baining, Talasea, and Gasmata.

Rabaul/Kokopo District.

In this area there are 58 plantations, comprising 14,274 hectares, of which 10,663 hectares are bearing. Approximately 2,000 hectares have been planted in recent years or are in the process of being planted, whilst further plantings are intended.

About twelve or thirteen early plantings should maintain their present level of production for a considerable period, whilst a number of estates are expected to decrease in output, in some cases very much in the near future. The majority of these properties are situated in the pumice belt, where in many instances not more than 5 or 6 cwt. of copra are produced to the hectare per annum. The output, however, is apparently maintained to a large extent by extensive trading in native grown coco-nuts.

Promecotheca sp., has been fairly bad on three or four plantations, the severity of the attack appearing to be more pronounced where the soil is evidently exhausted of its chemical constituents, which in itself has led to decreased vigour and dying back of fronds. On other plantations decreased vigour following soil exhaustion has resulted in a certain amount of premature nut-fall.

Taking the plantations in this district as a whole, notwithstanding some very poor estates, the yearly output of copra will be maintained.

Duke of York District.

This district consists of thirteen islands. The island of Mioko, which is 1 mile long and ¾ mile wide, has a large, deep, protected harbour, and is the principal settlement. There are four plantations comprising 524 hectares of coco-nuts of which 513 hectares are in bearing.

Production in this district should increase with the young areas coming into bearing.

Baining District.

In this district there are 22 plantations, comprising 4,977 hectares of coco-nuts, with 4,025 hectares in bearing.

There are five plantations that appear to be decreasing in yield, (one has already decreased), five others have newly planted areas, and the remaining estates should maintain their production for many years. It is believed that although the original plantings will probably decrease in yield, the output of the whole district will increase as the young areas come into bearing.

So far as suitable land for future development is concerned, there are 1,872 hectares on New Massava plantation, but only limited areas elsewhere, although there is quite a large area of land in the Keravat valley which could be reconnoitred.

Talasea District (including Witu and Bali Islands).

In this district there are fourteen plantations, comprising 3,404 hectares of coco-nuts, of which 2,657 are in bearing. On the mainland, production is bound to increase as the properties are young and the soil fertile, although certain estates have suffered considerably from Promecotheca infestation.

There is scope for development in this area, the rich soil derived from volcanic sand, scoriae, tuffs, and pumice, being deep and well drained, and although there are only one or two good harbours nevertheless small anchorages are to be found which are suitable for schooners.

The properties on Witu and Bali islands will either maintain their present level of production or increase. Some of the plantations yield exceptionally well, the production being slightly under 2 tons per hectare of copra per annum. One old estate on Witu Island has a large area of palms turning yellow, being planted on the hills, but owing to new plantings even this property will maintain its present production.

Gasmata District.

In the Gasmata district there are nine plantations, comprising 2,439 hectares of coco-nuts, of which 1,431 hectares are in bearing. On two or three plantations Sexava has been serious, and considerably reduced the yields. In several other areas, notably the Government Plantation, Promecotheca has been prevalent and yields have suffered greatly.

Except for those plantations where yields have been decreased by pests, it is anticipated that three plantations will maintain their production, whilst the remainder will increase. Control of pests in the badly infested areas should bring production back to normal.

The properties on which production will increase are all young, some of them just commencing to bear. On one large property that is barely holding its output the frontage is badly planted, the spacing being 20 ft. x 20 ft.

The soil in the Gasmata district is quite suitable for coco-nuts, although in certain areas there are outcrops of soap-stone, or a soap-stone layer just below the surface. There are areas available for future planting, but owing to pests and a rather excessive rainfall, other districts would probably prove more suitable for expansion.

Several fairly good harbours are to be found along the Gasmata coast, and there are many anchorages suitable for small craft.

Manus District.

This is an island district with a total area of about 1,000 square miles. The island of Manus, which is approximately 55 miles long by 16 miles wide, is the administrative centre.

Manus island is rugged and mountainous in the centre, fairly fertile, densely wooded, and together with several smaller islands adjacent to it, constitutes the Admiralty Group. Several useful harbours provide good anchorages for shipping purposes. There are 36 plantations, with about 8,400 hectares under coco-nuts.

Serious outbreaks of Sexava and Promecoteca have occurred in the Admiralty Group, and on estates that are free at present, infestation is liable to take place at any time. Sexava has been responsible for decreased production on certain plantations, and this pest plus poor sandy coral soils has caused a reduction in yield of about 28 per cent. on five small islands in the group.

Purdy Island, which has phosphate deposits, should maintain its present level of production, but on Alim Island the encroachment of the sea will cause a decrease. New areas coming into bearing should enable Pak Island to maintain its output in spite of Sexava.

Taking the plantations in the Admiralty Group as a whole, five should maintain their present level of production, three can be expected to decrease, and the remainder should increase on the present figures.

Situated to the north-west of the Admiralty Group and included in the Manus district, are a number of islands known as the Ninigo, Hermit, and Anchorite groups, which together form the Western Islands. With the exception of Allison Island, where phosphate deposits exist (and where one area of 22 hectares is giving the remarkable yield of 7 tons of copra per month), the production is decreasing despite certain new areas coming into bearing. Factors contributing to the general decrease in yield are poor sandy soil, bad drainage and swampy conditions prevailing in many instances, the large number of palms planted closely and haphazardly by the natives in the early days, and damage due to Sexava and *Aspidiotus destructor*.

So far as the Manus district is concerned, the Admiralty Group should maintain its present output, providing serious pest invasions do not constantly recur. In the Western Islands there will be a decrease in production.

New Ireland.

This district embraces the main islands of New Ireland and New Hanover, and the adjacent island groups of Tabar, Tanga, Lihir, Anir, Djaul, and Tsoi.

New Ireland lies close to, and runs practically at right angles to the northern end of New Britain. It is 200 miles long, with a mean width of 20 miles; is very mountainous, with a good deal of uplifted coral limestone formation, outcrops of limestone being found in the centre of the island at a height of approximately 3,000 feet. Geologically it is much older than New Britain, hence its volcanic activity has practically ceased. In the Namatanai area material resembling brown coal is to be found, and is used by the natives as fuel.

The coast line is fairly regular, with good harbours at Kavieng, Namatanai, Muliama, Labom, and Kalili; schooner anchorages are more or less confined to the west coast and central east coast, but are not numerous.

A large part of the island, particularly on the east coast, is under cultivation, there being many large European owned plantations. On the west coast of Namatanai, between Bom and Gil-Gil, are many small Asiatic plantations. The extreme northern end of the island, on the western side, is inclined to be swampy, and the southern end is very mountainous and rugged.

In June, 1935, on the 134 plantations there were about 27,060 hectares of coco-nuts in cultivation, of which 19,298 hectares are in bearing.

In the Kavieng section about five properties on the east coast are expected to decrease in yield. Most of the plantations on the west coast, however, should maintain or increase their output, as the palms are relatively young and new areas have been planted. There is still a certain amount of virgin land suitable for planting in this section, but the frontages are possibly the only areas worth developing, as land away from the beach is rather broken, and in some instances there are high limestone cliffs.

There are a number of good plantations in the Namatanai area from Karu to Maritzoan (east coast), which compare favorably with those in the northern end of Bougainville. On the west coast one rather large property is expected to decrease in yield.

In Namatanai there is little suitable virgin land available for planting owing to the lack of anchorage or loading sites. In some instances where there are anchorages, the land is unsuitable as the hills are far too steep. Portions of Namatanai have been subjected to a Sexava attack, and in the New Ireland district as a whole a suspected virus disease known as "head droop," "cabbaging," or "corkscrewing" is rather prevalent.

New Hanover.

This is a large, mountainous, well watered island about 40 miles by 20 miles in extent, lying north-west of New Ireland. The soil is mostly unsuitable for coco-nuts being heavy and clayey, although it should suit other crops quite well. Of the eleven properties on the island, few are yielding really well, and it might

be said that some estates should never have been planted as they are on some of the worst soil for coco-nuts in the territory. The average yield is only about 6 cwt. of copra per hectare, and in addition to unsuitable soil conditions, Sexava has also assisted in decreasing the yields in recent years.

Portland Islands.

These islands also appear unsuitable for coco-nuts, some thousands of palms having completely lost their crown, and the output must decrease.

Tanga and Waramung Islands.

The production should increase in these islands. In the former, 300 to 400 hectares of virgin land are available for planting.

Anir and Lihir Islands.

The production in these islands should increase by 75 per cent., as the areas are new and just coming into bearing. There is, however, only a limited area still available for planting.

Tabar Islands.

In the Tabar islands, considerable areas of the plantations are established on land that is apparently too wet and clayey for coco-nuts, and in two instances high and badly eroded hillsides have been planted. Although small areas have been newly planted, it is anticipated that the output in this group will decrease by possibly 10 per cent.

Djaul Island.

This island is producing well, and with new plantings is likely to increase in production.

Mussau Islands.

The output of this group will probably decrease owing to the presence of large areas of sand, and a very shallow surface soil.

Tsoi Group.

This group of islands may maintain their present level of production, although it is problematical whether the areas that are decreasing will be offset by the newly planted areas.

Generally speaking, the production in the New Ireland district should increase by about 20 per cent. in the future. A number of the older properties should maintain their output, while large areas (about 2,900 hectares) have been planted within recent years.

Kieta District.

The Kieta district, the late German Solomon Islands, has a total area of about 3,400 square miles. The district consists of the islands of Bougainville, Buka, Nissan, Feads, Cartarets, Mortlocks, and Tasmans, and supports 51 European owned plantations, comprising about 10,000 hectares, of which approximately 9,300 hectares have bearing coco-nuts.

Bougainville.

The largest of the Solomon Islands, extends in a north-east, south-west direction. The soil is of volcanic origin, varies in colour from chocolate to red, and is fertile.

An extensive forest-covered mountain range occupies a large proportion of the island, and rises to a height of 10,171 feet (Mt. Balbi), where one of the two active volcanoes is situated.

The foreshores are of raised coral limestone, the rainfall is heavy but well distributed, and the island is well watered by numerous short, rapid rivers, which however, tend to accumulate in coastal swamps in certain areas. There are some extremely good harbours such as Kieta and Buka Passage, and at nearly all plantations along the coast north of Kieta, good anchorages for small craft are available. It is noted that on the southern side of Kieta, anchorages are scarce.

About fifteen properties on the island will maintain their production, while eleven of these should increase in the future. As far as can be judged, there are few plantations in this area that are likely to decrease.

Buka Island, which is separated from Bougainville Island by a narrow passage, is also of volcanic origin. There are about eight European plantations on the main island, and a few islands in Buka Passage. Two of these plantations should never have been planted, as the land is too wet and swampy; they should, however, retain their small production, although one is already showing signs of going off. Two plantations should retain their yield, and may increase slightly, and one property established on poor badly drained soil will decrease considerably.

The other islands in the Kieta district, with the exception of *Nissan Island* (which contains some excellent coco-nut land with good anchorages inside a lagoon), will probably decrease in production, in fact one group appears to be already on the decline.

On Bougainville Island, there are three large areas of land between Buka Passage and Kieta, that are suitable for planting. The opening of roads, and the construction of bridges over some of the rivers in the Buin-Siwai-Nagovissi areas, would give access to a very large area of native palms which are producing well, and also to some very excellent land for planting. There is little land available on Buka Island.

So far as serious pests are concerned the Kieta district is fairly free, although Thread Blight (corticium penicillatum) is prevalent in the very sheltered areas of most plantations.

PROSPECTS.

In summing up the position for the whole territory, it will be seen that copra production should increase in the future. This increase, however, is due solely to new areas coming into production or reaching full bearing.

Reference is made throughout this section to the older properties. The oldest plantation in New Guinea is said to be 50 years old, but the majority are from 18 to 30 years of age [6]. That many of these plantations are decreasing in yield, or just maintaining production is alarming, when it has been proved that estates with proper management will continue to increase up to 60 years and even longer [2].

There are many island properties, particularly in the Kieta, Manus, and New Island districts that have already decreased in output, or will do so in the near future. On these island plantations there are instances in which adequate foreshore protection has been disregarded, hence recession has occurred. In other cases

the poor type of sandy soil is incapable of supporting economic coco-nut cultivation for any period, and neglect to assist the soils by maintaining the organic matter has materially hastened decrease in yields.

There are examples throughout the territory where coco-nuts have been planted on soils that are too heavy, or too wet and swampy for coco-nuts to thrive; further, steep hills have been planted, and no provision has been made to control erosion. There are instances of close and haphazard planting.

Pests are a problem in certain districts, especially Sexava and Promecotheca spp, and there is a most depressing effect on yields where infestations occur.

In recent years a big increase in new plantings has taken place, and comparatively large areas are still available for planting in some districts. It is most likely, however, that future development will not be so extensive or so rapid as in the past, being influenced by prices offering for the products.

It is contended that too much reliance should not be placed on the development of new areas to maintain output. Every endeavour should be made to increase the production by rehabilitation, newer and better methods of agricultural management, and consideration to pest control.

(*To be continued.*)

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COCO-NUT PESTS.

By John L. Froggatt, B.Sc., Entomologist.

Pests of the Trunk.

The large Dynastids, *Xylotrupes gideon,* L. (Elephant beetle), *Scapanes grossepunctatus,* Sternb. (Rhinocerus beetle) and *Trichogomphus semmilinki,* Rits. (Solomon Islands Rhinocerus beetle), cannot be classed as major pests of the palms, but are yet of considerable economic importance in that by means of their eating holes in the soft tissue at the base of the head of the palm they lead to admission of the Palm Weavils, which are very serious pests of the trunk and "cabbage". By attention to the reduction of the numbers of these beetles in any area the danger of infestation by the Palm Weevil is very greatly lessened.

The eggs are deposited in the soil and are small round white bodies, and reach maturity in about 20 to 29 days. Just before emergence the young larva can be seen through the chorion (integement of the egg).

The grubs are a creamy (dirty) white in colour with reddish-brown head and with the upper surface of the body carrying brownish hairs. They feed in the ground, gaining nutriment from the humus, and are always most plentiful in situations where their food is most abundant (e.g. in or under heaps of old decaying vegetation, &c.). The pupal stage is also passed in the soil.

The total life cycle (i.e., from deposition of egg to emergence of adult) occupies about 3-4 months.

Xylotrupes gideon and *Scapanes grossepunctatus* have a general range throughout this Territory and into the Solomon Islands, but *Trichogomphus semmilinki* has never been collected outside the Kieta District and is apparently confined to the Solomon Islands Group.

The males are distinguished from the females by having a marked sculptural development on the top of the head and thorax.

Xylotrupes gideon has two "horns" with bifurcated tips, one projecting forwards and downwards from the thorax and the other forwards and upwards from the top of the head.

Scapanes grossepunctatus has two projections forward from either side of the thorax and one "horn" curving upwards from the top of the head between the two projections from the thorax.

Trichogomphus semmilinki has the thorax deeply excavated and has a short bifurcated projection from the middle of the thorax on the upper surface and directed forwards, with two short projections forwardly directed from the sides of the thorax, and one "horn" curving upwards from the top of the head.

The first two species are a very deep brown to almost black in colour, the females of *X. gideon* having the upper surface hairy.

Both males and females of *T. semmilinki* are shiny black.

The size of both sexes and also the nature of the structures referred to on the males, vary considerably, but the following measurements are taken from well grown specimens and are from the tip of the "horns" to the "tail".

X. gideon—8.7 cms. long, 3 cms. maximum width.

S. grossepunctatus—5.5 cms. long, 2.5 cms. maximum width.

T. semmilinki—5.5 cms. long, 2.7 cms. maximum width.

Observations have been carried out in the Botanic Gardens, Rabaul, on the trees on which the large Dynastids (practically wholly *X. gideon, S. grossepunctatus* being rare in that locality though plentiful in the kanaka groves even adjacent) are collected and in their order of preference the trees mostly frequented by the adults are—

Poinciana regia
Cassia multijuga.

These, grown as trap trees and *carefully collected over every day,* will assist materially in reducing the numbers of these beetles in any locality.

As previously stated, these beetles breed in soil, particularly in situations where the humus content is high. Attention should therefore be paid, by due attention to general plantation hygiene, to preventing as far as possible, accumulations of old vegetation and such like. In one instance that came under the writer's notice, advice was sought for the reason of the large numbers of these beetles occurring at one plantation, and on an inspection being made, a pit was found in which cut grass, fronds of palms, &c. had accumulated, and when this pit was cleaned out 346 adults and a large number of grubs of the Dynastids were collected.

In another instance under similar conditions two full kerosene tins of beetles were collected from one pit.

Serious losses are at times occasioned by one or more of several species of *small Dynastids* (*vide* Part 2, Vol. 1, N.G.A.G. for identifications) eating into the developing bud of the young palm from the time of planting out up to about the first year and a half of growth. Owing to the feeding of these beetles on the "bud" the young palm is killed. As the damage is done before the palm wilts, the collection and destruction of these beetles presents very great difficulties.

These beetles are always worse on areas where the planting has been done on old grass lands or where taro has been growing, i.e, the natural breeding ground of these beetles.

The Palm Weevils.

There are three species of *Curculionidae* which cause material damage to coconut palms in this Territory, *Rhyncophorus papuanus,* Kirach (the Black Palm Weevil), *Rhyncophorus schach,* F. (the Red Striped Palm Weevil) and *Sparganobasis subscruiata,* Mshl. (the Base Borer). Of these, the two former are only able to penetrate the trunk when there is an opening such as may be made by the large Dynastids or by a knife cut, &c., and their attack is usually worse on relatively young palms and in areas where the plantation has been badly neglected.

The eggs are laid in any freshly made openings, and the larvae tunnel into the trunk of the palm and in the "cabbage"; if the bud becomes affected in the course of the channellings the palm dies.

Careful attention to pest control will reveal any openings liable to enable these pests to become operative, and if such are cleaned and tarred, no infestation will ensue.

If the larvae have already developed, by placing the ear close against the trunk they can generally be heard gnawing at the tissue, and the infested portion can then be readily located, cut out, and the cavity tarred.

The larvae of these two weevils are large creamy-white fleshy grubs with brown heads and strong jaws. The adults measure 3 cms. long and 1.25 cms. wide across the junction of the elytra (wing covers) with the thorax.

The adults of *Rhyncophorus papuanus* are a general dull black in colour, while *Rhyncophorus schach* have two red stripes on the dorsal surface of the thorax.

Both species breed freely in the Sago palm, and where these are growing adjacent to plantations the greatest care should be taken to see that any such which become infested are destroyed, and where they are worked for native food, that old stumps, heads, &c., of the palms are destroyed, as well as the old rotting waste.

The use of some fumigant would ensure the destruction of all larvae whereas in cutting out the affected parts small larvae are liable to be missed.

Previously, carbon disulphide was placed in the workings to kill the larvae, but the danger with this chemical is the high degree of explosive inflammability of its vapours when mixed with air.

Paradichlorbenzene (a white crystalline solid) would probably be just as effective and is both non-poisonous to humans and non-inflammable. It will certainly kill the larvae in the plant tissue.

The Base Borer, *Sparganobasis subscruciata,* is a smaller weevil, and as its popular name implies, attacks the bole of the palm, the larvae tunnelling at first more or less in the surface portion, but as the infestation develops, boring all through the bole. From the evidence in hand this appears rather to be a pest of relatively young palms, although old palms have also been reported to be attacked.

Although recorded from widely scattered sections of the Territory, it does not appear to be a pest in the same category as the two former species.

Pests of the Spathes.

Lepidoptera.

The large spathe moth *Tirathaba rufivena,* Wlk., is generally distributed throughout the Territory.

The eggs are laid on the spikes soon after the spathes open and the caterpillars feed on the male flowers, amongst which they form a webbing of silken fibre and frass; female flower buds are sometimes attacked and destroyed.

The attack is always most severe on spathes which are choked and are unable to open out freely. From observations made at the Demonstration Plantation, Keravat, the first five or six spathes thrown are the worst attacked, the following one being but slightly infested, if at all.

The larvae are reddish and are very quick in movement either backwards or forwards. The adult varies in appearance in the sexes, the female having the veins of the wings red, while the male is generally silvery-grey with a black margin to the fore wings. The adult measures about 2.5 cms. across the outspread wings.

In appraising the economics of *Tirathaba rufivena,* it must be remembered that a palm will only set a certain number of nuts, and this will be less than the number of female buds on any one spathe in most instances; consequently some of these buds will therefore be shed in the normal course of events. However, if the caterpillars of this moth cause a few buds to fall, unless the loss by this means is excessive, it is only carrying out nature's normal function. This is not to say that it is not of economic importance, for at certain times at least it can be a decided pest.

A small *Tineid moth* (unidentified) has bred from larvae collected inside unopened spathes from the Kieta District. The eggs in this case are apparently laid in the striae on the outside of the sheath, and the larvae bore through to the inside, the site of entry being marked by a minute globule of dried sap. It does not appear to do material damage, but might lead to the introduction of fungi, &c.

Rhyncota.

The Pentatomid (Stink Bug) *Axiagastas campbelli,* Dist., is prevalent all through the Territory, and where particularly so may lead to a slight amount of nutfall. It is present in all stages of development, both in the heads of the palm and on the opening spathes. Owing to lack of extended records on areas where this bug is present in large numbers, its economic importance is difficult to assess.

The adult is about 12 mm. long and 7 mm. wide, the upper surface black with lighter markings.

Coleoptera.

The large Dynastids (Elephant and Rhinocerus beetles) at times damage the female buds.

Two species of "Stag Beetles" (Lucanidae) feed on the male blossoms and sometimes damage the female buds. *Eurytrachelus egregius,* Mill. (the Black Stag), is dull black in colour; the males measure up to 5.5 cms. in length and 1.5 cms. in width. *Metopodontus bison,* Ol. (the Brown Stag), is shiny brown in colour, with a yellow margin round the wing covers and thorax. The males measure up to 5.5 cms. long and 1.25 cms. wide.

Two other species of Lucanidae, *Cyclommatus margaritae,* Gestro., and *Cyclommatus speciosus,* Boisd., have also been collected on newly opened coco-nut spathes.

The males in all the stag beetles have false "jaws" projecting in front of the head, and are commonly called "sisors" by the natives.

Three species of *Cetonidae* have been found feeding on the male blossom, *Lomaptera batchiana,* Thoms. (the Green Cockchafer) being the most numerous, the other species being *Panglaphyra douboulayi,* Thoms., and *Poecilopharis emilia,* White.

Other Coco-nut Insects.

Rhabdocnemis obscura, Boisd., and *Diocalandra frumenti,* are two other weevils which will oviposit in ends of cut fronds or where some opening has been made into the midrib of a frond. Although they may increase damage after it has been done by some other agency, they are only pests of secondary importance to coco-nut palms.

COCCID PESTS OF COFFEE.

By John L. Froggatt, B.Sc., Entomologist.

The commercial development of coffee cultivation in this territory is still in its early stages, and the areas are widely scattered.

There are two groups of the *Coccidae*, commonly known as "mealy bugs" and "scale insects". The former are soft-bodied insects covered with a waxy coat and capable of movement; the latter, once they begin to feed, become attached to the plant and develop a tough scaly covering. Both groups obtain their nourishment by puncturing the bark and sucking the sap. When plentiful, they take a considerable amount of sustenance from the plant.

It may be stated that it has been our *general* experience that these insects are much more prevalent during dry weather, the advent of heavy rains quickly leading to a reduction of the pest to a minimum.

Mealy Bug.

The worst pest infestation of coffee to date, has been the attack by a "mealy bug" (*Pseudococcus sp.*) which occurred on one coffee plantation in 1934. The area affected was at first relatively isolated, but the pest became rapidly dispersed until it embraced a considerable section of the area under crop. The dispersion appeared to have been very materially influenced by the prevailing winds.

It was first observed on bushes of *Erythrina* sp., cuttings of which had been introduced partly from trees in the surrounding bush for the development of permanent shade. Later investigations showed that the parent trees of *Erythrina* in the bush were heavily infested by this mealy bug, and that they were, moreover, in the direct line of the prevailing winds at the time of first noting the pest, and were situated only a short distance from the plantation.

After becoming established on the *Erythrina*, the pest quickly spread to the coffee and *Leucaena glauca*, also used as permanent shade. Spraying with various mixtures was tried, but the problem of control rapidly reached a stage where mechanical measures were impractical and uneconomic.

A small "ladybird" beetle (*Cryptolaemus* sp.?) followed the mealy bug into the plantation and increased at such a rate as to permit of distribution from one section of the area to another, and assisted by other factors, eventually gave a good measure of control.

In most cases mealy bug and scale insect infestation are accompanied by large numbers of small ants which protect these pests in order to obtain the sugary excretion (honey-dew) yielded by them, and preventing the natural parasites and predators from functioning. In the infestation referred to, although ants were present they were not in as great numbers as might have been expected.

H. C. James[1] Assistant Entomologist, Department of Agriculture, Kenya, writing on the subject of mealy bugs on coffee in that colony, states that there the prevention of ants gaining access to the trees is a necessary preliminary in order to obtain effective control by predators and parasites. For the purpose he advocates the use of a small cone (made of stiff grease-proof paper or metal) which can be

bound on to the trunk of the tree, and an ant repellant painted on the undersurface; high boiling-point tar oils or crude castor oil and corrosive sublimate are stated to be cheap and with a sufficiently long period of effectiveness as to be of economic value. Banding should never be done direct on to the trunk of the tree, otherwise damage to the bark is liable to ensue.

In reference to the utilization of parasites, James gives a technique for breeding of ladybird beetles in captivity for distribution in the plantation, of which a brief summary is of interest to coffee growers in this territory.

Mature potato tubers are set out in damp sand in trays in a dark place, which must be well ventilated but free from draughts direct onto the plants, and maintained at a temperature of 75° to 80° Fahrenheit; as sprouts develop the tips should be nipped off. When a sufficient stage of growth has been reached, the sprouting tubers are placed in trays in cages made of a light wooden frame work, and covered with calico or similar material on three sides and top and bottom. The fourth side is a door made in two parts and hinged on the side. The lower half of the cage carries the trays of sprouts, and the upper half is left vacant for the collection of the adult ladybird beetles, which tend to move towards the top of the cage. The doors must fit tightly otherwise the insects are liable to escape.

When the sprouts are placed in the cage, they are infested with mealy bugs from the coffee bushes; the numbers introduced should only be sufficient to develop a moderate infestation, otherwise the food plants will be killed before the predators can mature.

When the pest is well established, adult ladybird beetles are placed in the cages, and as the succeeding generation matures the adults can be collected and distributed. The greatest care must be exercised in handling the insects as they are very easily damaged and they will then die.

On coffee plantations where mealy bug infestation has occurred even periodically, it would be an excellent plan to maintain a small "nursery stock" of ladybird beetles to have on hand at the beginning of an outbreak of the pest, and the notes given above may be of assistance in outlining the measures to be adopted.

Great care must be taken in collecting the ladybird beetles in the field to make sure that only those that *are* predators are collected, as some members of this group of beetles are pests themselves.

The Green Coffee Scale.

The green coffee scale, *Coccus viridis,* is common on a number of bushes other than coffee.

This is a small insect covered by a very thin transparent shell which shows green in colour on the leaf. They are usually most prevalent along the midrib on the undersurface of the foliage, but when plentiful they more or less cover the whole of the undersurface. Under the latter conditions especially, the foliage will show a sooty appearance due to the development of a fungus on the "honeydew" excreted by the insects. This is removed by the spray used to kill the scale.

Spraying.

Owing to the nature of the protective coverings of these insects, the spray fluid must be of such a nature as to remove sufficient of the waxy coat as to reach the insect underneath, and in the other case to penetrate under the shell.

It must, therefore, be one of three types, firstly, corrosive (alkaline), secondly penetrative (light oil) or thirdly generate gases that will kill the insects.

Of the first and third, lime sulphur spray fluid is an example, and of the second, a light to medium oil so combined in a water mixture that on being sprayed on to the foliage the oil is liberated quickly and stays on the foliage while the water runs off.

The apparatus by which the spray is to be applied must depend on the general terrain of the area, and its size.

Where the area is more or less in the nature of a garden, a strong pneumatic knapsack spray pump, fitted with pressure gauge, should be sufficient, but where plantation conditions have to be considered, a portable power sprayer with three or four jets will prove much more satisfactory than a battery of smaller spray outfits.

The spray nozzles should deliver a fine misty spray on to the plants; where shade trees have to be treated, a spray-lance will most probably be required.

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METEOROLOGICAL OBSERVATIONS.

KAVIENG.—Headquarters of Administration District of New Ireland, is situated 2° 34′S by 150° 49′E on North Cape in the straits separating the islands of New Ireland from Lavongai. The country surrounding Kavieng is flat, gradually becoming undulating as the higher country is approached.

The soil is a sandy loam mixed with shells and coral débris on a coral formation.

The average rainfall from 1917-1935 is 118.26 inches.

The rainfall throughout the northern part of New Ireland is regular and the number of days on which rain falls each month show little variation. The wettest period is the north-west monsoon from January to April and the comparatively dry period is from August to November. The south-east monsoon commences in June and gradually diminishes until October.

Even in the driest month, September, the average is not less than 7.31 inches, while the heaviest average fall for any month is some 11.70 inches in April.

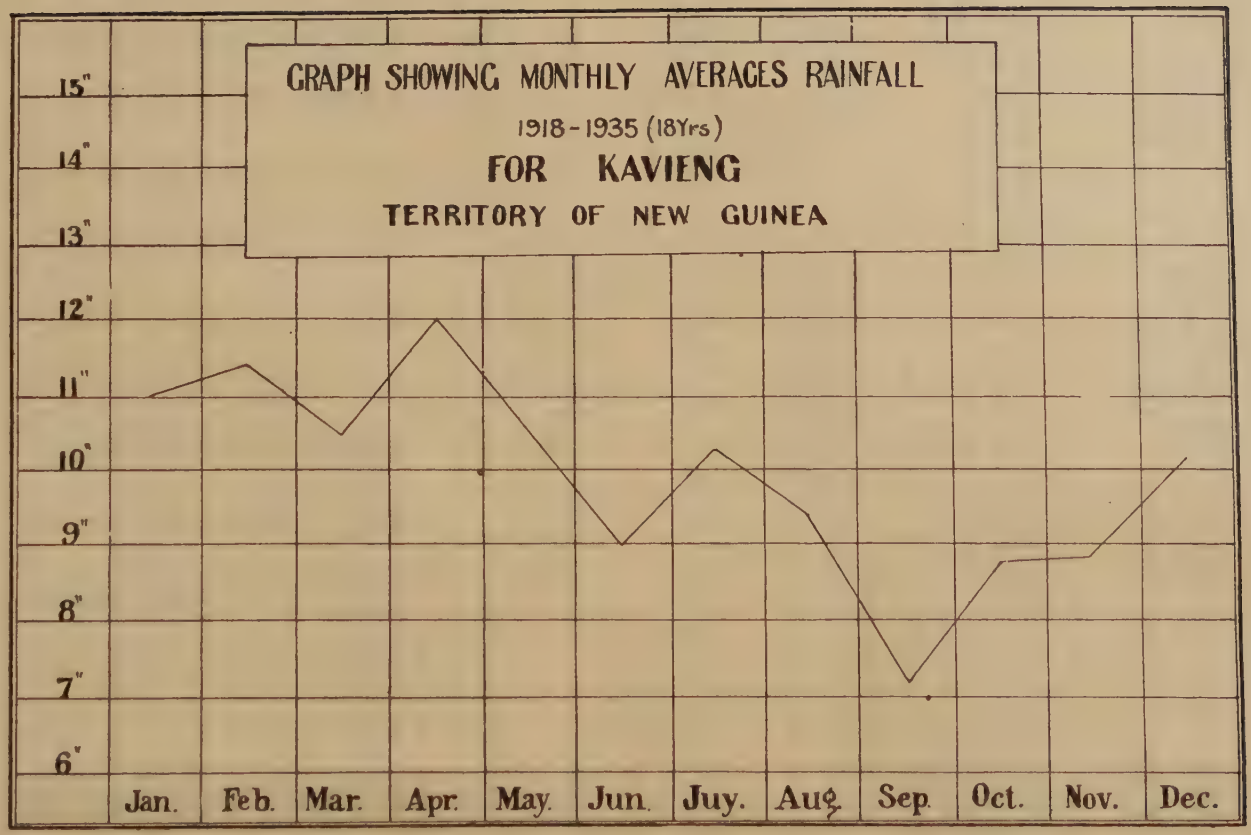
The average temperature and humidity records are very similar to those of Rabaul.

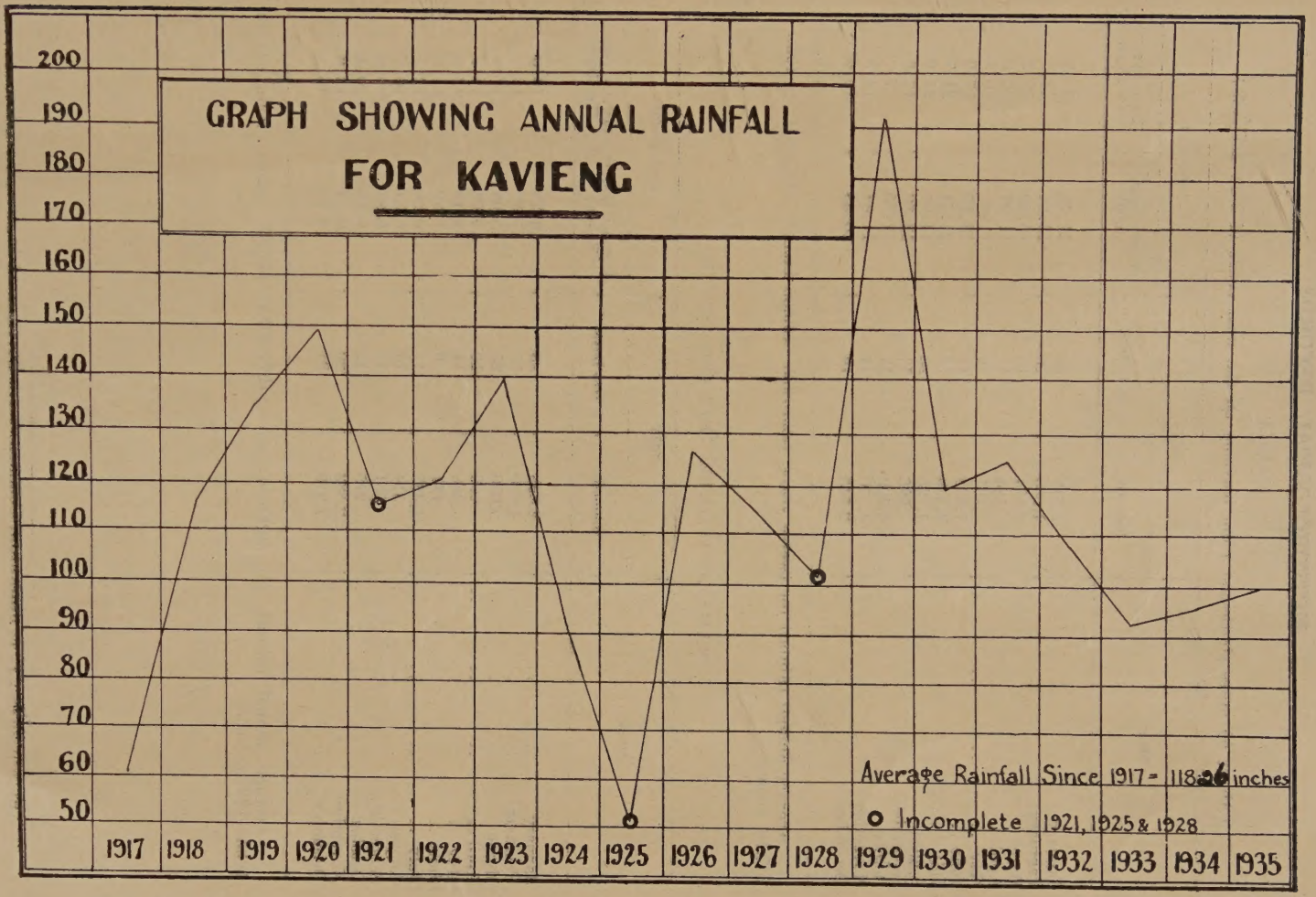
The annual mean humidity records at 9 a.m. readings are: Dry bulb 83.7°, Wet bulb 78.0°; a humidity of 76° while the average annual minimum and maximum temperatures are 72.5° and 89.1° respectively indicating a mean temperature of 80.8°.

MONTHLY AND YEARLY RAINFALL TOTALS AT NEW IRELAND DISTRICT. (IN POINTS) STATION—KAVIENG.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Total.
1917	1,406	140	453	524	521	486	361	896	538	87	247	437	6,096
1918	496	928	1,131	1,134	1,338	1,293	1,228	1,052	163	995	891	910	11,559
1919	1,324	1,987	1,332	1,922	1,168	1,603	741	613	882	537	609	748	13,466
1920	1,357	1,370	2,583	1,010	778	834	1,164	1,294	1,811	871	611	1,367	15,050
1921	1,040	467	1,026	2,646	1,245	686	*	*	808	1,139	1,506	1,082	11,645
1922	906	1,643	1,325	923	1,608	477	1,427	760	644	623	556	1,262	12,354
1923	3,007	1,011	748	1,081	649	1,980	1,111	819	695	945	1,072	845	13,963
1924	1,317	2,037	714	431	960	360	412	130	462	643	809	965	9,240
1925	*	*	*	545	847	486	380	*	271	1,005	619	1,020	5,173
1926	1,211	737	2,215	1,000	1,349	1,060	1,188	1,415	544	766	885	384	12,754
1927	1,234	960	548	1,146	658	664	776	1,762	167	718	1,549	1,331	11,513
1928	586	*	*	761	1,213	1,018	797	904	705	2,243	756	1,343	10,326
1929	1,588	1,166	979	2,039	1,270	1,619	1,785	2,457	1,485	1,577	1,365	1,830	19,160
1930	1,274	1,697	1,068	1,213	1,279	814	1,179	807	446	564	279	1,283	11,903
1931	562	1,044	1,133	1,587	1,727	879	928	481	718	809	1,574	1,055	12,497
1932	1,084	1,553	1,172	927	847	668	976	468	843	593	534	1,177	10,842
1933	639	1,590	1,419	1,192	705	704	558	743	244	280	826	368	9,268
1934	278	530	583	803	505	605	1,012	1,090	1,824	643	776	989	9,638
1935	278	587	662	1,341	1,014	446	1,037	488	639	1,593	1,032	845	9,962
Average	10.88	11.44	11.23	11.70	10.36	8.78	9.48	9.52	7.31	8.75	8.68	10.13	118.26

* No records taken during these months.


GRAPH SHOWING MONTHLY AVERAGES RAINFALL
1918-1935 (18Yrs)
FOR KAVIENG
TERRITORY OF NEW GUINEA
15"
14"
13"
12"
11"
10"
9"
8"
7"
6"
Jan.
Feb.
Mar.
Apr.
May.
Jun.
Juy.
Aug.
Sep.
Oct.
Nov.
Dec.


GRAPH SHOWING ANNUAL RAINFALL
FOR KAVIENG
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
Average Rainfall Since 1917 = 118.26 inches
o Incomplete 1921, 1925 & 1928

METEOROLOGICAL RECORDS.

KALILI.

(About 90 miles south-east from Kavieng on the west coast of New Ireland.)

Month.	1935.		Averages for—	
	Rainfall.	Wet Days.	(Twelve years) Rainfall.	(Twelve years) Wet Days.
January	2,789	26	21.28	21.7
February	1,260	10	13.84	18.9
March	2,584	19	16.89	19.2
April	584	11	11.97	16.9
May	2,161	16	11.36	16.5
June	1,238	11	13.19	17.9
July	4,339	19	21.74	21.7
August	1,735	20	14.99	21.9
September	896	14	15.50	17.5
October	2,309	17	17.50	17.2
November	1,770	14	11.41	14.8
December	2,545	14	20.33	16.6

Average annual rainfall for twelve years, 1923-1935—190.00 inches. Rainfall for 1935—242.10 inches.

NAMATANAI (NEW IRELAND, SOUTH).

Month.	1935.		averages for—	
	Rainfall.	Wet Days.	(Eighteen years) Rainfall.	(Twelve years) Wet Days.
January	2,583	23	19.38	19.0
February	1,880	17	17.52	18.4
March	2,650	25	15.66	17.9
April	690	10	14.58	15.0
May	968	14	9.10	12.5
June	141	6	7.80	11.2
July	1,397	17	9.26	12.7
August	514	14	6.31	10.8
September	551	12	5.83	9.9
October	915	15	8.65	10.4
November	2,583	20	10.54	13.6
December	1,970	21	17.14	15.8

Average annual rainfall for eighteen years, 1917-1935—141.77 inches. Rainfall for 1935—168.42 inches.

By Authority: L. F. JOHNSTON, Commonwealth Government Printer, Canberra.